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Date: 3 Aug 2005

Lisa L Pringle
Signature

Lisa L. Pringle
(type or print name of person certifying)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

William F. Courtney, et al.

Serial No.: 10/662,255

Filed: September 15, 2003

Group Art Unit: 2407

Examiner: Quochien B. Vuong

For: *Asymmetric Assignment of Space-Borne Communications System Resources*

DECLARATION UNDER 37 C.F.R. §1.131

Sir:

We, William F. Courtney, Richard L. Vogel, and Raymond M. Nuber, the undersigned, declare as follows:

1. We are the inventors of the invention entitled "Asymmetric Assignment of Space-Borne Communications System Resources," disclosed and claimed in U.S. Patent Application Serial No. 10/662,255 (hereinafter referred to as "the Application"), filed on September 15, 2003 and which is a continuation application of U.S. Serial No. 09/516,105 (hereinafter referred to as "the Priority Application"), filed March 1, 2000.

2. We conceived the subject matter that is disclosed and claimed in the Priority Application and the Application prior to the June 25, 1999 filing date of U.S. Patent 6,650, 630 (Haartsen), while employed for a predecessor-in-interest to the Assignee.

3. Prior to June 25, 1999, we prepared a written description in the form of a PowerPoint® presentation of various aspects of Asymmetry, including the subject matter claimed in the Priority Application and the Application. The written description was updated on March 3, 1999, presenting evidence that the subject matter was conceived at least prior to March 3, 1999. A redacted copy of this written description is attached hereto as Exhibit A.

4. On July 9, 1999, we completed a second written description in the form of a PowerPoint® presentation of various aspects of a Rough GW Estimation, including the subject matter claimed in the Priority Application and the Application. A redacted copy of this second written description is attached hereto as Exhibit B.

5. On July 29, 1999, we submitted an invention disclosure relating to the Priority Application and the Application. A redacted copy of the invention disclosure is attached hereto as Exhibit C.

6. On August 9, 1999, a facsimile from Lorna L. Schott (Patent Administrator for the Assignee) requesting preparation of a patent application was forwarded to William M. Wesley, Esq. at the law firm of McAndrews, Held & Malloy, Ltd.. The facsimile included the disclosure for the invention described in the Priority Application and the Application under docket number 36-0052. A redacted copy of the facsimile is attached hereto as Exhibit D.

7. On September 8, 1999, a fascimile from Lorna L. Schott providing supplemental pages for the disclosure for the invention described in the Priority Application and the Application under docket number 36-0052 was sent to Ron Larson, Esq. at the law firm of McAndrews, Held & Malloy, Ltd.. A redacted copy of the facsimile is attached hereto as Exhibit E.

8. On September 14, 1999, Marilyn L. Beaumont sent a drawing per the Priority Application under docket number 36-0052 to John F. Nethery, Esq. at the law firm of McAndrews, Held & Malloy, Ltd.. A redacted copy of the letter accompanying the drawing is attached hereto as Exhibit F.

9. On September 23, 1999, John F. Nethery, Esq. sent a letter to Lorna L. Schott that included a draft of the Priority Application, which was prepared by the law firm McAndrews, Held & Malloy, Ltd.. A redacted copy of the letter is attached hereto as Exhibit G.

10. On October 4, 1999, Lorna L. Schott sent an interoffice correspondence to William F. Courtney that included a draft of the Priority Application, which was prepared by the law firm McAndrews, Held & Malloy, Ltd.. A redacted copy of the interoffice correspondence is attached hereto as Exhibit H.

11. On February 3, 2000, a fascimile from Lynn Cabiles requesting a workable diskette containing the draft of the Priority Application was sent to John Nethery, Esq. at the law firm of McAndrews, Held & Malloy, Ltd.. A redacted copy of the facsimile is attached hereto as Exhibit I.

12. On February 4, 2000, John F. Nethery, Esq. sent a diskette to Lorna L. Schott containing a copy of the draft of the Priority Application, which was prepared by the law firm McAndrews, Held & Malloy, Ltd.. A redacted copy of the letter accompanying the diskette is attached hereto as Exhibit J.

13. On February 9, 2000, Lynn Cabiles sent an interoffice correspondence to William F. Courtney that included a second draft of the Priority Application, which was prepared by the law firm McAndrews, Held & Malloy, Ltd.. A redacted copy of the interoffice correspondence is attached hereto as Exhibit K.

14. We believe that the Priority Application was filed in the U.S. Patent Office on March 1, 2000.

15. We believe a Notice of Allowability for the Priority Application was mailed by the United States Patent Office on June 17, 2003.

16. We believe the Application, which is a continuation application of the Priority Application was filed September 15, 2003.

17. We believe the Priority Application issued as U.S. Patent No. 6,665,518 on December 16, 2003.

18. We declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

William F. Courtney — Date 7/26/2005

Richard L. Vogel — Date 8/1/05

Raymond M. Nuber — Date 8/1/05

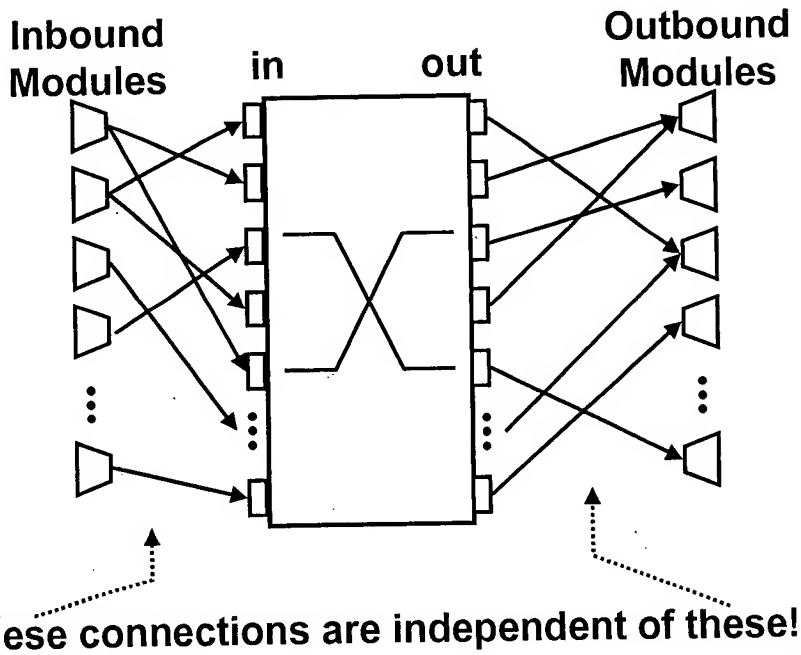
EXHIBIT A

TRW

Asymmetry

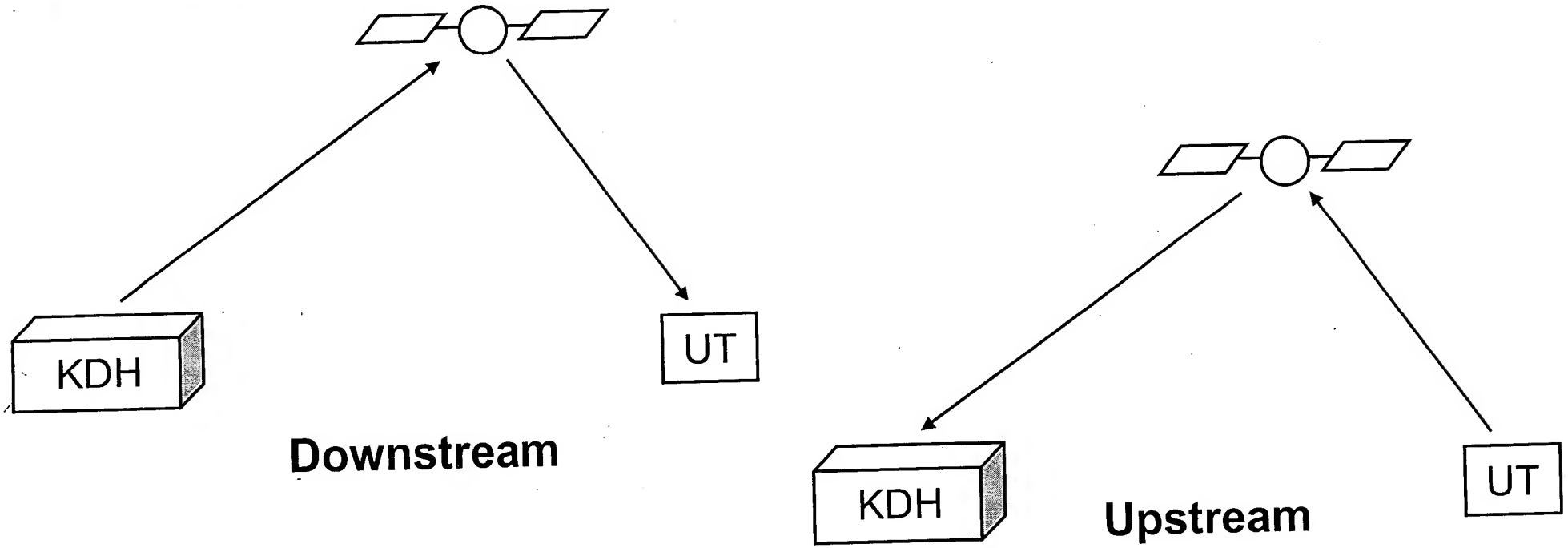
- **We tend to think of beams as comprising both an**
  - Uplink
  - Downlink
- **However, there is no compelling reason for this to be the case**
- **There is a reason why *this should not be the case*:**

  Web-surfing traffic is asymmetric, with something like 10 times as much downstream traffic as upstream traffic
  - Upstream traffic
    - **Uplink from user terminals**
    - **Switching on-board the satellite**
    - **Downlink to KDH**
  - Downstream
    - **Uplink from KDH**
    - **Switching on-board the satellite**
    - **Downlink to user terminals**



Upstream and Downstream in Our System

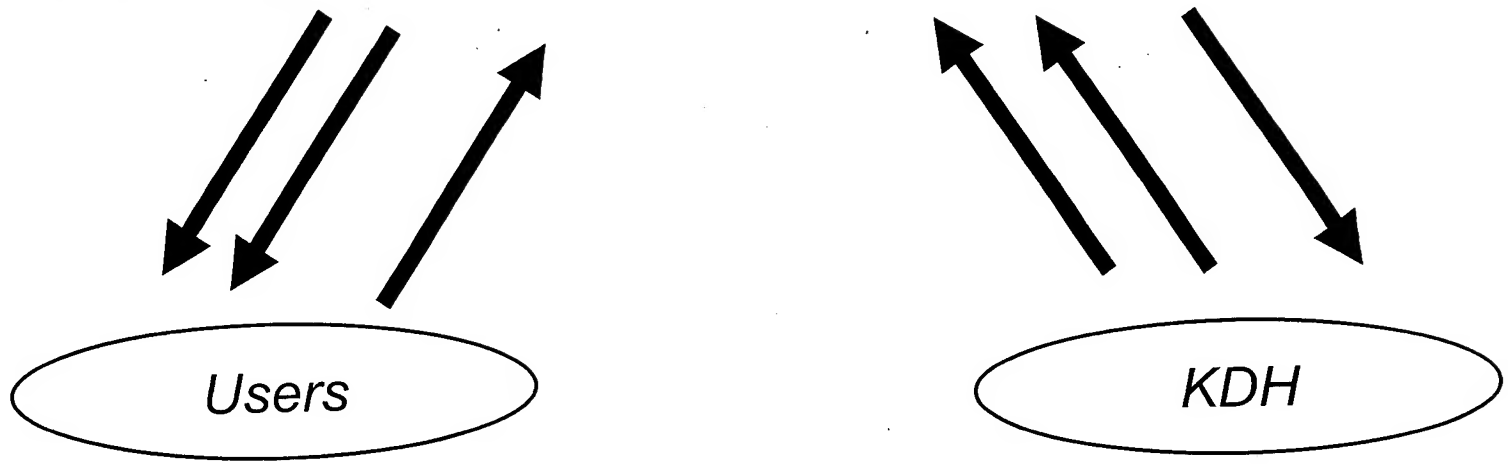
TRW



Downstream traffic is roughly 10x upstream traffic, so why should we allocate each the same bandwidth?

An Alternative, Asymmetric Allocation of Bandwidth

TRW



- Users can be supported with more downlink and less uplink
- KDH can be supported with more uplink and less downlink

- This type of allocation would match up better with Coyote needs
  - More bandwidth available where it is needed: ***Downstream***
  - Less bandwidth wasted where it is not needed: ***Upstream***

Background: Distribution of Entities and Resources in the System

TRW

- 86 uplink beams, total across the satellite
- 86 downlink beams, total across the satellite
- 44 user spots (aka cells)
- N KDHs (separated so that full frequency reuse is possible)
- 4 x 125 MHz x 2 polarities user bandwidth
- 4 x 125 MHz x 2 polarities KDH bandwidth
  (User bandwidth is distinct from KDH bandwidth)
- Bandwidth provides
  - **151+ Mbps per uplink beam**
  - **116+ Mbps per downlink beam (76.85% the capacity of an uplink beam)**
- Maximum number of downlink beams to users: 62 across the satellite
- Minimum number of uplinks from users: 46 (one per spot)

Example Asymmetric Allocation of Bandwidth to Users and KDHs

TRW

- **Allocation of uplinks and downlinks**
  - 62 downlinks to users
    - **One per spot to start**
    - **Leaves 18 downlink beams to be assigned to areas of higher subscription**
  - 46 uplinks from users (one per spot, the minimum)
  - 12 downlinks to KDHs (24 are available)
    - **Two per KDH**
    - **Saves satellite power by not using 12 of the 24 remaining downlinks**
  - 40 uplinks from KDHs (all that are left after the users take 46)
    - **Implies a minimum of 5 KDH, since each can have at most 8 uplink beams**
    - **Assume that each of the 5 KDH has 8 uplink beams**
- **Results of this allocation**
  - 40 uplinks from KDHs provide 6.05 Gbps to users
  - 62 downlinks to users provide 7.20 Gbps to users
  - 46 uplinks from users will need to carry about 605 Mbps (10% of 6.05 Gbps)
  - 12 downlinks to KDHs can carry 1.39 Gbps (~43% loaded)

Comparison of Bandwidths Available to Users

Best Symmetric vs. Best Asymmetric Allocations

TRW

- **If we insist on a symmetric assignment of bandwidth (i.e., if we insist that each downlink be accompanied by an uplink), the best balance we can obtain between the two downstream links is**
  - 49 user beams: downlink capacity, 5.69 Gbps
  - 37 KDH beams: uplink capacity, **5.59 Gbps**

- **The example asymmetric assignment has its bottleneck in the KDH uplink, 6.05 Gbps**
  - This is an 8% increase in total bandwidth over the best symmetrical arrangement
  - 6.05 Gbps to the users is the maximum

    We cannot give any more uplinks to the KDHs and still put one uplink in each user spot

Advantages of the Asymmetric Allocation

TRW

- **Maximizes downstream bandwidth to the users**
- **Saves satellite power by removing 12 downlinks to KDHs**
- **In the downstream, the downlinks' total bandwidth exceeds the uplinks' total bandwidth by 8% providing some margin for reducing on-board queuing and required buffer sizes**

  (See page 9 for discussion of an alternative flow control concept)
- **In the upstream we have considerable excess bandwidth (assuming that upstream traffic is ~10% of downstream traffic)**
  - In a user spot, if that spot had <u>two downlinks fully loaded</u>
    - **Total downstream to the users would be 232 Mbps**
    - **Upstream from those users would be 23 Mbps (15% loading of the uplink)**
  - Total downlink to the KDHs is 605 Mbps (43% of the capacity of the downlinks assigned to the KDHs)
- **<u>DRAWBACK</u>: With only one uplink per user spot, no user spot can have more than 36,400 users. (Each user must have an uplink time probe slot.)**

TRW

Alternative Flow Control Concept: Ground-Based Flow and Call Admission Control

- **Given the example allocation, we have 5 heavy-duty KDHs**
- **Suppose we parcel out the 62 user beams among these KDHs, so that *all the users in a given user beam connect to the same KDH***

  - Thus each KDH has sole responsibility for 12 or 13 user beams (The assignment of user beams to KDHs could change from time to time.)
  - Given a downstream downlink, only one KDH is KDH putting any downstream traffic into that downlink. *This KDH can exercise real-time flow control and call admission control (CAC) on the ground*
    - **Any trouble created on the ground would be re-created in space 125 ms later**
    - **If congestion is avoided on the ground, it is guaranteed that it will be avoided in space**
    - **The latency problem which plagued flow control and CAC is eliminated**
    - **The 12 or 13 beams run by a KDH can be spread across the country and assigned so that the expected loads at each KDH are roughly equal**
    - **Spreading may create a PoP problem for multiple ISPs**

Proposed Trade Studies

TRW

- **Asymmetric vs. Symmetric Bandwidth Allocation**

- **Ground-Based Flow and Call Admission Control Using Total-User-Beam-Assignment (TUBA)**

  vs.

  Space-Based or Ground-Based Control with Distributed User Assignment

EXHIBIT B

Quick & Dirty Coyote Gateway Estimation

TRW

Assumptions:

- Available Uplink Bandwidth: 151.2 Mbps
- Available Downlink Bandwidth: 114.0 Mbps
- Losses
  - **User Uplink: 15%**
  - **G/W Uplink: 5%**
  - **User Downlink: 10%**
  - **G/W Downlink: 5%**
  - **Downlink loss because of DOCSIS: 1/48**
- Target maximum utilization of G/W downlinks: 70%
- Combined Peak Use Discount because of Time-of-Day: 0.9
- Gateways located at triple points

Resulting Up & Downlink Bandwidths

TRW

- **User Uplink: 128.5 Mbps**
- **G/W Uplink: 143.6 Mbps**
- **User Downlink: 100.5 Mbps**
- **G/W Downlink: 106.0 Mbps**

Some Numeric Derivations

TRW

- **Number of User Downlinks Supported by one G/W Uplink:**

  (G/W Uplink BW / User Downlink BW) / ToD Discount
  (143.6 / 100.5) / 0.9 = **1.588**

- **UULR = User uplink rate per fully used user downlink**

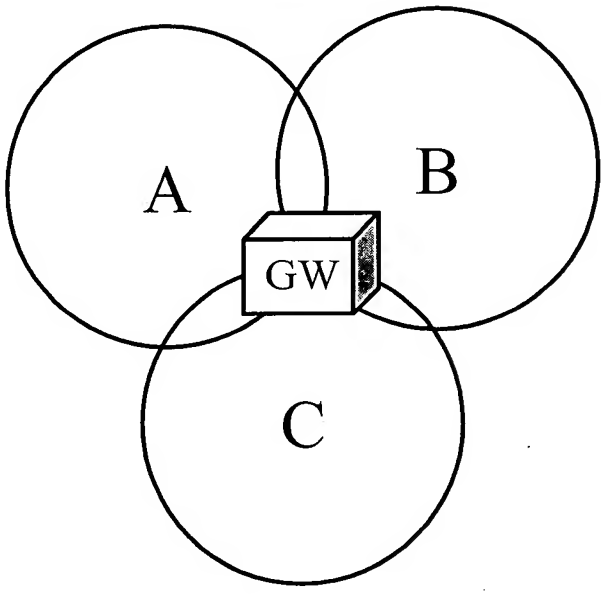
  User Downlink BW / Downstream:Upstream Ratio

- **Number of User Uplinks Supported by one G/W Downlink**

  [(G/W Downlink BW * Max Utilization Factor) / UULR] / ToD Discount
  [(106.0 * 0.7) / UULR] / 0.9 = **82.4 / UULR**

Gateways at Triple Points

TRW



- After assigning beams to cells A, B, and C, each of the cells must have at least one downlink for users and enough uplink to support one user downlink
- We would like to distribute user beams fairly evenly over our 46 cells, so we would like to take beams for G/W use from A, B, and C so that each is left with about the same number of user beams
- We don't want to have many triples with beams assignments of 3, 2, and 2 beams to cells A, B, and C, respectively, since there are very few beams left which can be assigned to nearby cells. I.e., only "corner" cells can be assigned 3 beams

Magic Numbers for G/W Support of User Beams

TRW

# GW Uplinks	User D/Ls Supported	Approx. # GW Uplinks
25 Y-channels	1	---
1 beam + 10Ys	2	1
1 beam + 32 Ys	3	---
2 beams + 19 Ys	4	2
3 beams + 6 Ys	5	3
3 beams + 28 Ys	6	4

D/S : U/S	User Uplink Rate (Mbps)	Number of User U/Ls Supported per Gateway D/L
7.3 : 1	13.77	6
6.1 : 1	16.48	5
4.9 : 1	20.51	4
3.7 : 1	27.16	3
2.4 : 1	41.88	2
1.0 : 1	100.50	1

A First Cut at How G/Ws Might Support User Beams

TRW

D/S : U/S Domain	Total # User D/Ls Supported	Total Number G/Ws Required	---Gateway Types--- # G/Ws	# G/W U/Ls	# G/W D/Ls	Total G/W U/Ls	Total G/W D/Ls
7.3 : 1 & higher	66	13				40	13
			1	4	1		
			12	3	1		
6.1 - 7.3 : 1	66	13				40	14
			1	4	2		
			12	3	1		
4.9 - 6.1 : 1	62	12				40	24
			1	4	2		
			12	3	2		
3.7 - 4.9 : 1	62	12				40	24
			1	4	2		
			12	3	2		
2.4 - 3.7 : 1	54	11				34	30
			4	4	3		
			6	3	3		
1.0 - 2.4 : 1	42	19				38	42
			4	2	3		
			15	1	2		

NOTES:

1) At most 3 or 4 cells need to have 3 beams
2) Oft times, beams lay fallow with these assignments or the G/Ws support more user beams than there are left after assignment to G/Ws
3) This is only a first cut at number of G/Ws and user beams supported

EXHIBIT C

310-812-7391

TRW PROPRIETARY INVENTION DISCLOSURE

RECEIVED

AUG 02 1999

TRW

See Instructions on Last Page of This Form

Docket No. 36-0052

Date 7/29/99

Title of Invention: Mechanism for Asymmetric Assignment of Space-Borne Communications System Resources

Inventor(S)

Full Name (No Initials)	Badge No.	Division	CCC	TRW Mail Station	Extension	Immediate Supervisor
William Francis Courtney	076419	DSD	Y810	201/3702	27391	Roger Ciesinski
Richard Lee Vogel	070236	ITD	3LHD	201/3013	27328	James Belt
Raymond Mark Nuber	104236	ETD	D601	201/3400	32136	Steve Lunny

Conception of Invention

Date of First Written Description of the Invention 3/3/99

In Engineering Notebook? Yes ☐ Notebook No _____ Page _____

No ☒ If No, Identify the Written Description and Indicate Where Located

Coyote IOC Log # 97-CO-027, file "asymmetry.ppt," dated 3/3/1997

Date of the First Oral Disclosure 3/4/99 To Whom? Christopher E. Kelly

Date of First Drawings or Sketches 3/3/99 Present Location File."asymmetry.ppt"

Construction And Test

Invention Constructed Or Modeled Yes ☒ No ☐ Date 7/9/1999

By Whom? Courtney, as reported in computer files "Rough GW Estimation.ppt" and "GW Estimate.xls"

Invention Successfully Tested? Yes ☐ No ☒ Date _____

By Whom? _____

Names of Witnesses to the Construction or Testing

Were Formal Drawings Made Yes ☐ No ☐ If Yes, Drawing Nos. _____

Use

Was Invention the Subject of Commercial Activity? Yes ☐ No ☒
(Commercial Activity Means External to TRW and Includes Activity with the Government)

If Yes (A) Date of First Executed Sales Contract _____

(B) Identify First Sale Contract No. _____

(C) Date Of First Delivery To Customer _____

Date of First Commercial Activity, Either with Commercial Customers or in a Proposal to Government _____

Is Commercial Activity Imminent? Yes ☒ No ☐ Expected Date 9/30/99

Publication

Has a Description of the Invention Been Published? Yes ☐ No ☒

If Yes, Provide Copy and Identify Publication and Date

If The Invention Has Been Described in a Customer Report Provide Copy And Identify the Customer Report by Customer, Date, and No.

Did the Customer Report Have a TRW Proprietary Legend? Yes ☐ No ☐

Has the Invention Been Described to People Not Employed by TRW? Yes ☒ No ☐

If Yes (A) Was Disclosure Under a Confidential Disclosure Agreement Yes

(B) Provide Names of Person(S), Their Employers(S), Date, and Place of Disclosure

Tom Moore, Michelle Kuska, Jeff Weaver, and Andrew Sundelin, all of KaSTAR satellite Communications Corp, Englewood, CO on 3/28/1999

Related Printed Publications and Reference Material

Identify Any Patents, Printed Publications, Written Reports, or Proposals Relating to Closely Analogous Concepts, and Provide Copies None known

Identify Any Prior TRW Invention Disclosures, Patent Applications, or Issued Patents Relating to the Invention

None known

Contract or Project Information (Must Be Completed)

The Invention First Conceived While Charging Time to Job No. 98BWDY And Working on:

☐ Government Contract or Subcontract No. _____ Title _____

☒ TRW Funded (IR&D, B&P, PM&P) Project No. 98BWDY Title Coyote

☐ Commercial Contract No. _____ Customer _____

☐ Other, Explanation _____

Contract Administrator _____

The Invention First Conceived While Charging Time to Job No. _____ And Working On:

☐ Government Contract or Subcontract No. _____ Title _____

☐ TRW Funded (IR&D, B&P, PM&P) Project No. _____ Title _____

☐ Commercial Contract No. _____ Customer _____

☐ Other, Explanation _____

Contract Administrator _____

Problem or Need

A satellite communications system's capacity is a limited and expensive resource. Mechanisms for maximizing the utilization of this resource would significantly increase the effective capacity of the system and increase the revenue that the system can produce.

Inventive Concept (What It Does and How It Does It)?

The invention makes asymmetric (unequal) assignments of uplink and downlink bandwidth to parties or groups of parties using a satellite communications system. It makes the assignments according to the needs on the parties or groups, maximizing the utilization of resources. See the attachment following this form for details of the operation of the invention.

Prior Art

Symmetric (equal) assignments of uplink and downlink bandwidth to one party or group of parties and a different equal assignment of uplink and downlink bandwidth to the other party or group of parties.

Inventor W. F. Courtney	Date 7/30/99	Inventor R. L. Vogel	Date 7/30/99	Inventor R. M. Nuber	Date 7/30/99
Witnessed, Read and Understood by:		7/30/99	Witnessed, Read and Understood by:		7/30/99
	Witness	Date		Supervisor	Date

Advantages

Asymmetric assignment of satellite bandwidth increases the effective capacity and the revenue production of the system by dramatic amounts (50% and more)

Government, Industrial or Commercial Applications

Any communications satellite system

Illustrations and/or Examples (Attach Drawings)

See attached document for Figures 1. through 4.

Inventors Names, Social Security Nos., Home Addresses and Telephone Numbers

1. William F. Courtney, 350-44-9732, 2801 Montair Ave., Long Beach, CA 90815, 562.420.8252

2. Richard L. Vogel, 557-72-8274, 2553 Via Anita, Palos Verdes Estates, CA 90274, 310.378.0928

3. Raymond M. Nuber, 513-80-3021, 27919 Alvarez Dr., Rancho Palos Verdes, CA 90275 310.265.9540

4.

Inventor W. F. Courtney	Date 7/30/99	Inventor R. L. Vogel	Date 7/30/99	Inventor R. M. Nuber	Date 7/30/99
Witnessed, Read and Understood by:		7/30/99	Witnessed, Read and Understood by:		7/30/99
	Witness	Date		Supervisor	Date

Inventive Concept (details): The invention exploits the asymmetry in two-way communications between parties over satellite. This method of exploitation assigns bandwidth to the parties according to their needs. The matching of bandwidth assigned to bandwidth needed maximizes the utilization of the capacity of the system.

In a preferred implementation, one party in the communications is one or more large terminals called gateways. The other party is a large number of smaller user terminals. Continuing the description of this preferred implementation, the users are web surfers and the gateways belong to Internet Service Providers (ISPs). The users send far less traffic to the gateways than the gateways send to the users. Ratios such as 10-to1 and 20-to-1 have been reported by ISPs.

The relevant entities in a satellite communications system are illustrated in Figure 1. The function of the controller entity will be explained below. The satellite can be any type of communications satellite. For example, it can be a bent-pipe satellite, an analog multiplexer satellite, an analog switch satellite, a digital processing satellite, or a hybrid type. The links between the satellite and the ground entities can be of any modulation type and can have any physical make-up and link layer protocols. The invention can exploit the available features of the satellite and the links to maximize the system's effective capacity. For example, if the satellite has a concentrating function such as a statistical multiplexer which removes some or all of the unused bandwidth in the uplinks before putting traffic in the downlinks, the invention can consider the presence of the concentrator in its determination of bandwidth assignments. Also for example, if the uplinks comprise many smaller sub-channels, the invention can assign bandwidth on a sub-channel-by-sub-channel basis rather than on a coarser link-by-link basis.

The remainder of this explanation will describe the invention operating in the preferred implementation or in a variation thereof.

There are two directions for traffic flows through the satellite communications system. The direction from the users to the gateway is called "inbound." The direction from the gateway to the users is called "outbound." Note that each of the inbound and outbound directions has an uplink to the satellite and a downlink from the satellite. The inbound uplink is also called the user uplink, since it connects the users up to the satellite. The inbound downlink is also called the gateway downlink, since it connects the satellite down to the gateway. For similar reasons, the outbound uplink is also called the gateway uplink and the outbound downlink is also called the user downlink. These directions and links are illustrated in Figure 2.

The mechanism for implementing the invention uses a controller. The principal functions of the controller are to assign satellite uplink and downlink bandwidth to the users and the gateways and to communicate these assignments to the users and gateways. Any means may be used for this communications of assignments, but in the preferred implementation, the communications is made via a broadcast signaling channel carried through the satellite to the users and gateways. This signaling channel requires a very small amount of bandwidth and may be taken from any available uplink and downlink.

An optional capability of the controller is to monitor the amounts of bandwidth granted to and used by the users and gateways. The ratio (granted bandwidth / used bandwidth) is called the utilization efficiency. Note that there are separate utilization efficiencies for the users and the gateways and that there may be separate utilization efficiencies for the uplinks and the downlinks. In fact, there may be different utilizations for different gateways and different groups of users as well. The invention can operate at a very fine or a very coarse level of refinement, depending upon the needs of the system and the detail of information available. If the controller does not monitor the granting and use of bandwidth, approximations or a priori values can be used.

The functionality that monitors bandwidth granted and used may be part of the controller or it may be part of another system entity. In the latter case, a communications between the controller and the monitor will be part of the system.

In the preferred implementation, the controller assigns bandwidth to the users and to the gateways in proportion to the quotient

(traffic / utilization efficiency). [1]

Figure 3 gives an example of the invention in operation and illustrates the advantages conferred by the invention. In the figure a single beam of a bent-pipe satellite covers users and a gateway. Each uplink and downlink in the example has a capacity of 1 traffic unit. The measured or presumed ratio of traffic flow is 10-to-1 outbound-to-inbound. The utilization efficiency of the user uplinks is assumed to be 0.3 (33% efficiency), while the efficiency of the gateway uplinks is assumed to be 1.0 (100% efficiency). The satellite does not have a concentrator and the links are indivisible.

Under these circumstances, the controller would assign outbound to inbound bandwidth in a 3:1 ratio. The explanation of this determination is as follows.

The user uplink (inbound uplink) quotient according to expression [1] is (1 * 0.1/0.3) = 0.333 traffic units per traffic unit received by users. Similarly, the gateway uplink (outbound uplink) quotient is (1/1.0) = 1 traffic unit per unit sent. Since the satellite is non-concentrating, the downlinks in the inbound and outbound direction must be assigned bandwidth equal to the uplinks in the same direction. (That is, the inbound downlink and the outbound downlink utilization efficiencies are equal to the corresponding inbound uplink and outbound uplink efficiencies.) Thus, the user downlink which completes the outbound direction must also have the quotient 0.333, and the gateway downlink must have the quotient 1. Since users receive every traffic unit sent by the gateway, the quotients are tied together. The controller assigns the inbound direction 1/3 the bandwidth it assigns the outbound direction. In this example, four uplinks and four downlinks are available in the cell. Three uplinks are assigned as gateway uplinks, and one of the downlinks is assigned as a gateway downlink. The remaining links are assigned to the users. Note that the beam was provisioned with equal bandwidth in the uplinks and downlinks. Although the uplink and downlink bandwidth was balanced, the controller assigned it asymmetrically. If we had used a default

assignment of two uplinks and downlinks to the users and two uplinks and downlinks to the gateways, only 2 traffic units of outbound traffic and 0.2 traffic units of inbound traffic would have been carried. The invention improves the effective capacity of the system by 50%.

Figure 4 illustrates a more complicated example. There are three beams in this example. Beams 1 and 2 have users only, while beam 3 has users and a gateway. The satellite has a statistical multiplexer onboard. Because this stat mux has been placed on board, the system designers, realizing that some of the uplink is very likely to be empty (and hence will be discarded onboard), have given the uplinks more capacity than the downlinks. While the downlinks can carry 1.0 traffic units, the uplinks can carry 1.5 traffic units. Again the outbound-to-inbound traffic ratio is 10-to-1, the user uplink utilization efficiency is assumed to be 0.3, and the gateway uplink traffic efficiency is assumed to be 1.0. As in the previous example, the links themselves are indivisible and each must be assigned entirely to the user or to the gateway.

The gateway (outbound) uplink quotient from expression [1] is (1/1.0) = 1 traffic unit per traffic unit sent, while the user (inbound) uplink quotient is (1 * 0.1 /0.3) = 0.333 traffic unit per traffic unit received. The ratio is, as before, 3-to-1. However, this time the satellite has a concentrator onboard.

The effect of the concentrator is to give all downlinks an efficiency of 1.0. Again, all uplinked traffic must be downlinked. The outbound downlink needs (1/1.0) = 1 traffic unit per traffic unit sent, while the inbound downlink needs (1 * 0.1 / 1.0) = 0.1 traffic units per traffic unit received by the users. Thus, we obtain the following assignment quotients:

Gateway uplink:	1.0
User uplink:	0.333
Gateway downlink:	0.1
User downlink:	1.0

Recall that uplinks have 1.5 times the capacity of downlinks in this example. Thus care must be taken when forming ratios between uplink and downlink assignments. The final ratios are:

Gateway uplink:	1.0
User uplink:	0.33
Gateway downlink:	0.15
User downlink:	1.5

The controller will assign 3 gateway uplinks for each user uplink and 10 user downlinks for each gateway downlink. In the example, for reasons beyond the control of the controller, the system designers can provide 10 or fewer uplinks, total, and 10 or fewer

downlinks. The asymmetric assignment capabilities of the controller enable the designers to distribute the links as follows:

Gateway uplinks:	6
User uplinks:	3 (Two would be preferable, but each beam must have one)
Gateway downlinks:	1 (0.9 would be preferable, but only whole numbers can be used)
User downlinks:	9

This assignment allows the system to carry 9 traffic units to the users and 0.9 traffic units to the gateways. Further, the system designers do not need to include the circuitry for one uplink, since it is not required.

Note that the mechanism instructs the designers to make an unbalanced provisioning of uplinks and downlinks in the beams. Beams 1 and 2 each are given three downlinks and one uplink. Beam 3 is given four downlink and seven uplinks. All the links in beams 1 and 2 are user beams. In beam 3, three downlinks and one uplink are user links, while six uplinks and one downlink are gateway links.

In this example, if the designers had used the default assignment, they would have had 5 user uplinks and downlinks and 5 gateway uplinks and downlinks. Very likely, each of beams 1 and 2 would have been assigned two user uplinks and downlinks, and beam 3 would have been assigned one user uplink and downlink and four gateway uplinks and downlinks. The system capacity would have been 5 traffic units. The invention increases system capacity by 80% in this example.

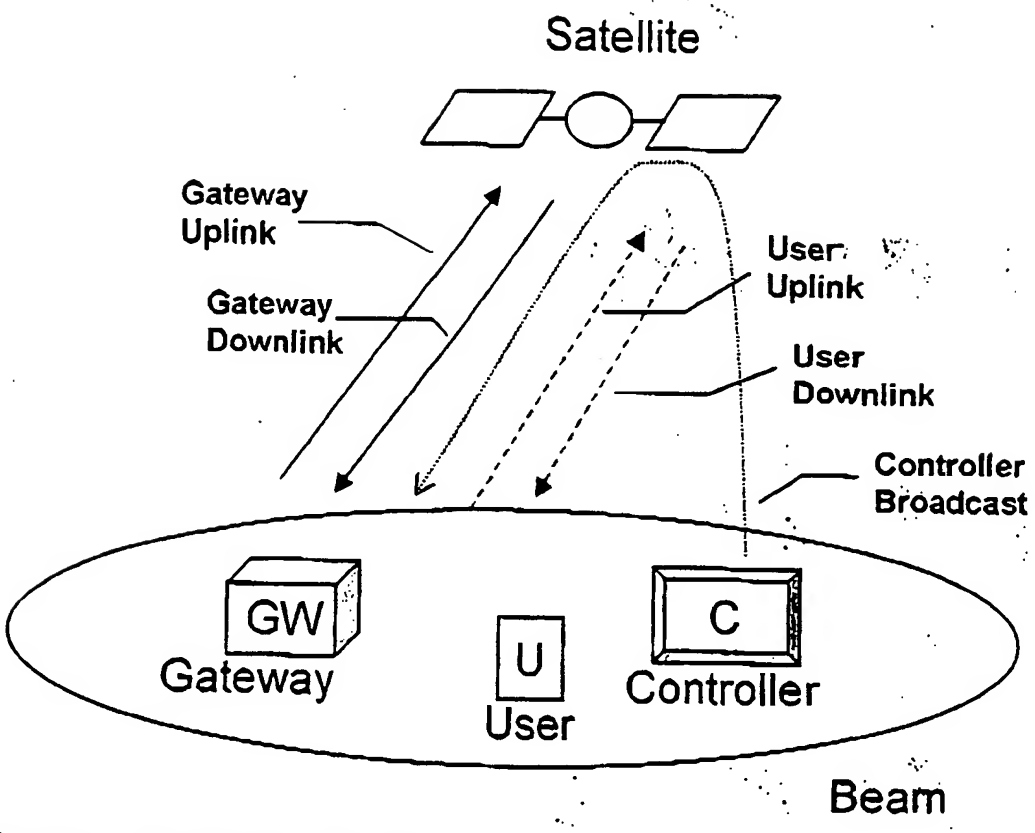
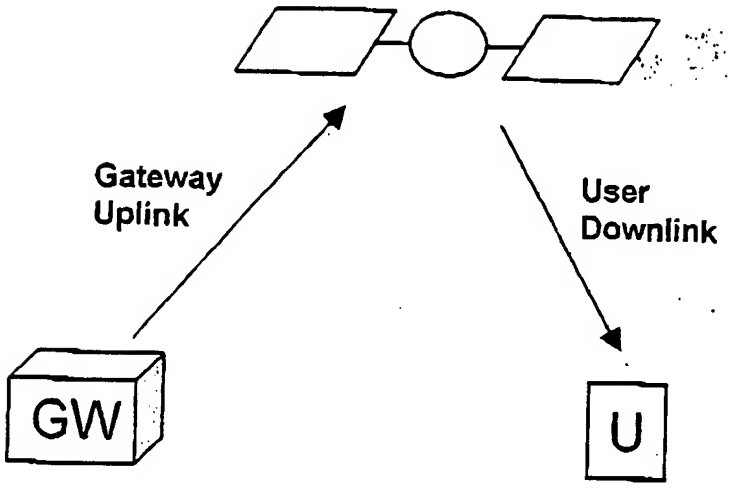
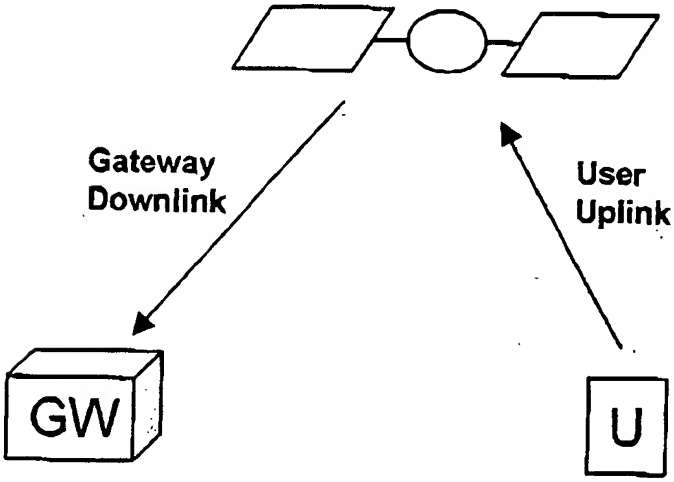


Figure 1: Relevant Satellite Communications System Entities



a. Outbound Direction



b. Inbound Direction

Figure 2: Illustration of Terms

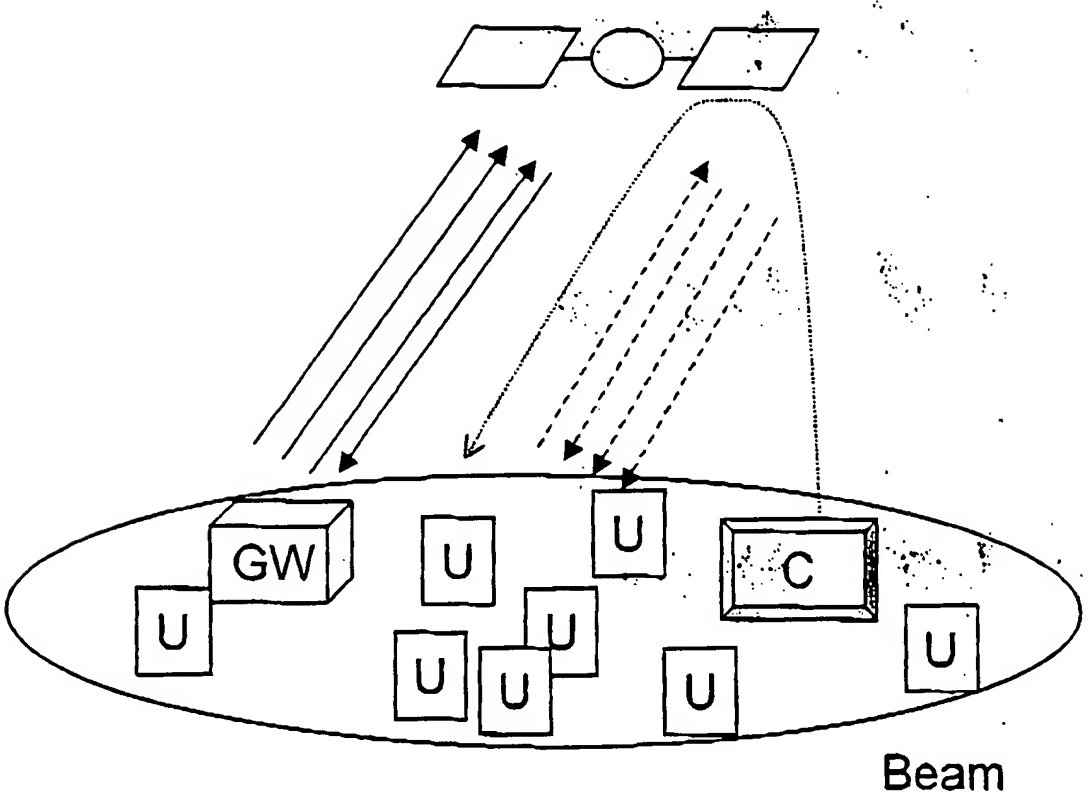


Figure 3: First Example of Controller Asymmetric Bandwidth Assignment

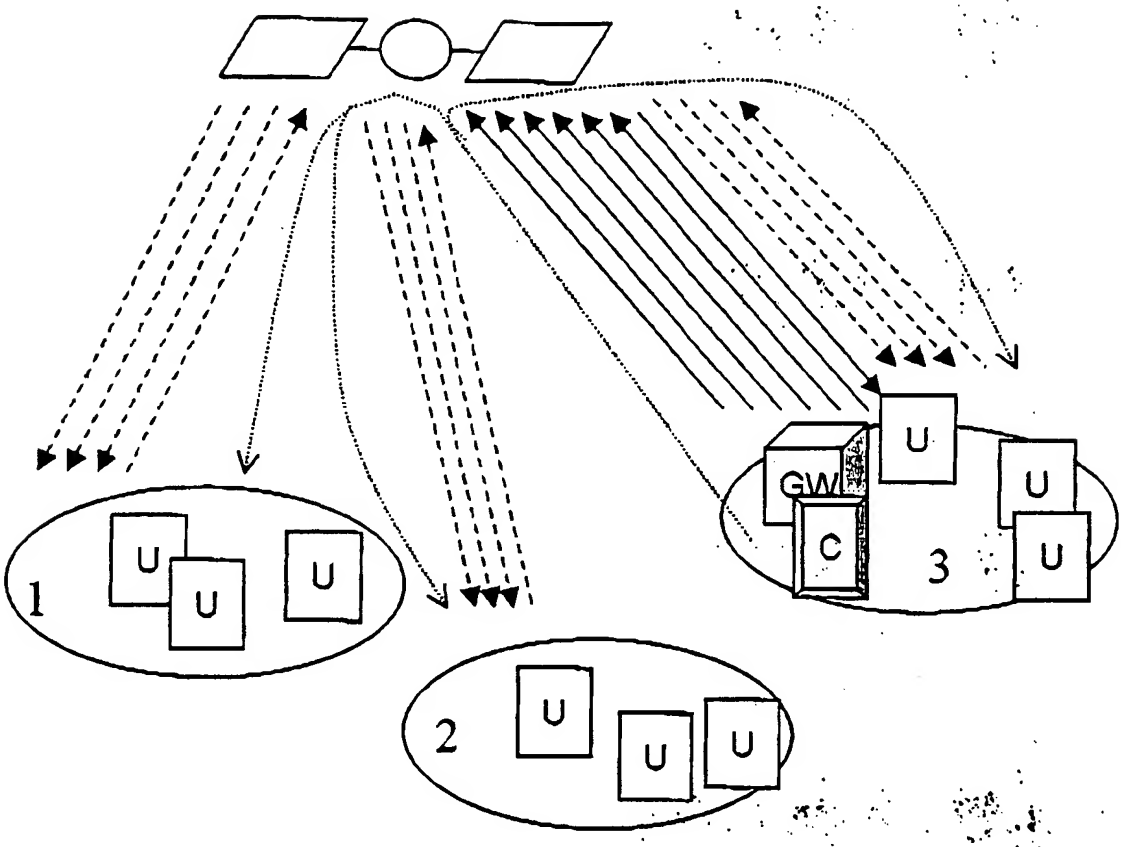


Figure 4: Second Example of Controller Asymmetric Bandwidth Assignment

EXHIBIT D

TRW Inc.

One Space Park
Redondo Beach, CA 90278
310.812.4321

Law Department

Bldg. E2/6072
Telephone: 310.812.1534
Telecopier: 310.812.2687

August 9, 1999

VIA TELECOPIER AND U.S. MAIL

William M. Wesley, Esq.
McAndrews, Held & Malloy, Ltd.
Northwestern Atrium Center
500 W. Madison, 34th Floor
Chicago, Illinois 60661

Subject: TRW Docket No. 36-0052
"Mechanism for Asymmetric Assignement of Space-Borne Communications System Resources"
Inventors: William F. Courtney, et al.
Last Day to File Application: **03/28/2000**
Billing Unit: SEG/DSD - Billing Code: 312

Dear Bill:

Enclosed is a copy of the above-referenced invention disclosure. No formal patentability search will be conducted in this matter.

It would be appreciated if you would prepare a patent application for the invention disclosed in the above docket. **The last day to file the patent application is March 28, 2000.** Therefore, the first draft of this application should be delivered to me no later than six (6) weeks from the date of this letter or **September 20, 1999**. Your response as to whether or not you are willing to so prepare the application should be transmitted to me within one week from the date of this letter. If your firm is willing to prepare the application and it will be prepared by someone other than yourself, please indicate the name of the attorney who will be preparing the application.

If you need more information before you begin preparing the application, please call my assistant, Marilyn Beaumont, (310) 812-1518 to set up a meeting (either personal or telephonic) with the inventors so that they can provide details of the invention(s). You should also be aware that all transmittals of drafts and comments should be directed through me, and not directly between you and the inventors, so that I can keep track of the progress of the preparation.

Your initial transmittal of the draft application(s) should include:

- the standard government contract clause, when applicable,
- a specification with claims,
- informal drawings,
- an Information Disclosure Statement on Form PTO-1449 signed by you,
- an abstract with reference numerals suitable for filing in foreign jurisdictions,
- draft application on 8 ½" x 11" bond paper (Specification and Abstract numbered in multiples of 5 and each claim separately numbered consecutively starting with 1, and
- **a copy of the application on diskette readable by Microsoft Word running on a P.C. enclosed in a protective cover.**

The transmittal should also indicate whether or not there are any statutory bars running of which you are aware, and whether or not there are any impediments to our filing corresponding foreign applications.

So that there is no question as to division of responsibilities, this office will be responsible for the preparation of the formal papers (declaration, power of attorney, assignment) and the actual filing of the application.

I look forward to working with you to obtain the best patent coverage we can for this invention. If you have any questions concerning this matter, please do not hesitate to contact me or Michael Yatsko at 310.812.4910.

Sincerely,

Lorna L. Schott
Patent Administrator

/lls
Enclosure

EXHIBIT E

** TX STATUS REPORT ** AS OF SEP 08 '99 13:53 PAGE.01

TRW LAW DEPT

	DATE	TIME	TO/FROM	MODE	MIN/SEC	PGS	CMD#	STATUS
26	09/08	13:51	913127079155	EC--S	01'59"	008	135	OK

TRW

Space and Electronics Group

One Space Park, E2/6072
Redondo Beach, CA 90278

Law Department

FACSIMILE COVER SHEET

FAX Number - (310) 812-2687

Wednesday, September 8, 1999

To: Ron Larson, Esq.
McAndrews, Held & Malloy

Phone: 312.707.8889
Fax: 312.707.9155

From: Lorna L. Schott

Phone: (310) 812-1534

Total number of pages (including lead sheet) - 8

Re: TRW Docket No. 36-0052 Your File No. 12489US01

Pursuant to your request, faxed herewith are the supplemental pages for the above-referenced invention disclosure.

EXHIBIT F

Marilyn L. Beaumont

TRW

Sept. 14, 1999

John Nethery, Esq.
McAndrews, Held & Malloy

John:

Enclosed please find one drawing from Bill Courtney per your request re Docket No. 36-0052.

Marilyn

/mlb

Enclosure

EXHIBIT G

JFT-MEK

LAW OFFICES

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D. DAVID HILL
THOMAS J. WIMBISCUS
STEVEN J. HAMPTON
PRISCILLA F. G
STEPHEN F. SH
PATRICK J. ARI
GEORGE F. WHI

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MATTHEW G. McANDREWS
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ROBERT A. SURRETTE
JAMES P. MURPHY
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JOSEPH M. BARICH
TIFFANY M. BROOKS
SCOTT P. McBRIDE
PATRICIA J. McGRATH
ANDREW C. SCHULTZ
ANDREW M. EVEREST

OF COUNSEL
S. JACK SAUER

PLS SEND TO INVENTORS FOR REVIEW

September 23, 1999

Ms.
TRW, Inc.
One Space Park
Building E2/6072
Redondo Beach, CA 90278

Re:	ASYMMETRIC ASSIGNMENT OF SPACE-BORNE COMMUNICATION SYSTEM RESOURCES
TRW Docket:	36-0052
Our Case No.	12489US01

Dear Lorna:

Enclosed is a copy of a draft of the patent application directed to the above-identified invention including the drawings and a copy of the subject application on diskette readable by Word 6.0 running on a P.C.

With reference to the discussion of Figure 6, I believe it would be beneficial if Mr. Courtney could extend the example to the case where $Num_{down}=8$. I would be happy to incorporate into the specification any resulting additional text.

Sincerely,

John F. Nethery

JFN/mg
Enclosures

EXHIBIT H

Interoffice
Correspondence

TRW

LAW DEPARTMENT

Subject:
TRW Docket No. **36-0052**
Title: ASYMMETRIC ASSIGNMENT OF SPACE-BORNE COMMUNICATION SYSTEM RESOURCES

Date:
October 4, 1999

From:
Lorna L. Schott

To:
William F. Courtney (201/3702)

cc: w/o attachments
Richard L. Vogel (201/3013)
Raymond M. Nuber (201/3400)

Location/Phone:
E2/6072 Ext. 21534
22687 FAX

This IOC requests that you review the **draft patent application** prior to filing in the United States Patent and Trademark Office. The drawings will be considered informal until the case is ready to be allowed. At that time, we will have formal drawings prepared. ***It is up to the first-listed inventor to forward the draft application onto the other co-inventors for review.***

Please review this application and make your changes, revisions and/or comments (in red or blue ink) and return to me no later than October 21, 1999.

/mlb

Enclosures

EXHIBIT I

TRW

Law Department

One Space Park, E2/6072
Redondo Beach, CA 90278

FACSIMILE COVER SHEET
FAX - (310) 812-2687

Contact Number - (310) 812-2411

Thursday, February 3, 2000

To: John Nethery
McAndrews, Held & Malloy

Phone: 312-775-8000
Fax: 312-775-8100

From: Lynn Cabiles

Phone: (310) 812-2411

Total number of pages (including lead sheet) 1

TRW Docket No.: 36-0052
Your Reference No. 12489US01

We are unable to read the disk you mailed with your letter of September 23, 1999. Please Airborne another disk containing the above application in Word 6.0 for the PC.

We will be finalizing the application in our office.

Thank you.

EXHIBIT J

LAW OFFICES

McANDREWS, HELD & MALLOY, LTD.

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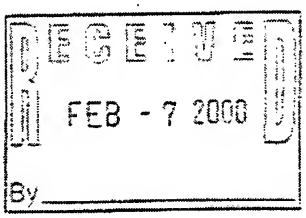
WILHELM L. RAO
SANDRA A. FRANTZEN
RONALD H. SPUHLER
MARY L. KELLY

OF COUNSEL
S. JACK BAUER

February 4, 2000



VIA AIRBORNE EXPRESS

Ms. Lorna L. Schott
TRW, Inc.
One Space Park
Building E2/6072
Redondo Beach, CA 90278

Re:	ASYMMETRIC ASSIGNMENT OF SPACE-BORNE COMMUNICATION SYSTEM RESOURCES
TRW Docket:	36-0052
Our Case No.	12489US01

Dear Lorna:

As requested in your facsimile of February 3, 2000, enclosed is a copy of the subject application on diskette readable by Word 6.0 running on a P.C.

Sincerely,

John F. Nethery

JFN/mg
Enclosure

EXHIBIT K

Interoffice Correspondence

TRW

LAW DEPARTMENT

Subject:	Date:	From:
TRW Docket No. **36-0052** Title: "Asymmetric Assignment of Space-Borne Communication System Resources"	February 9, 2000	Lynn Cabiles

To:	cc: (w/out enclosures)	Location/Extension
William Courtney (201/3702)	Richard Vogel (201/3013) Raymond Nuber (201/3702)	E2/6072 Ext. 22411

PURPOSE

This IOC requests that you review the **draft patent application** prior to filing in the United States Patent and Trademark Office. The drawings will be considered informal until the case is ready to be allowed. At that time, we will have formal drawings prepared. **It is up to the first listed inventor to forward the draft application on to the other co-inventors for review.**

Also enclosed is a Declaration and Assignment. Patent law requires the inventors to make a sworn statement that they have read, understood and agree with the adequacy and correctness of the description of the invention provided by their lawyers in the patent application. In particular, inventors should make certain that:

1. the application, drawings and specification:

   a. contain a complete disclosure of the invention;

   b. include enough information to teach a person skilled in the art how to practice the invention; and

   c. disclose the best means for practicing the invention;

2. the application claims identify the unique features of the invention which distinguish it from earlier inventions.

Since we have a bar date of March 4, 2000, please make your changes, revisions and/or comments on the copy (in red or blue ink) and return it to me no later than February 18, 2000. If you have no further changes, please call and let me know.

Enclosures